R2R Navigation Standard Products Format Specification (2011-02-09)

Introduction:

We define three R2R navigation standard products to be produced from each cruise: NavBestRes, Nav1Min, and NavControl. These three products specify the ship's time-stamped positions. The first three columns of each product contain (1) a single string for date and time, (2) longitude, and (3) latitude. The NavBestRes product is a quality-controlled product based on the ship's best GPS antenna position files provided in the ship's data distribution. It includes additional columns: (4) GPS quality indicator (defined by NMEA-0183), (5) number of GPS satellites, (6) horizontal dilution of precision, and (7) the GPS antenna height above/below mean sea level [meters]. "BestRes" refers to the fact that this product represents the highest resolution in time and allows for differences among vessels (or among legacy data) in the time interval used for recording the ship's position. Common practice among vessels is to collect position data at the maximum rate capable of today's marine GPS receivers: once-per-second. Times are specified at one-minute intervals in the Nav1Min product. The NavControl product is a subset of the Nav1Min product, just enough points to draw a ship-track on a map.

Date and time:

The ISO8601 time standard defines the order of date and time to be year, month, day, hour, minute, second, followed by a time-zone identifier. Section 6.2.3 of RFC5424 goes a step farther and specifies the characters used to separate these quantities and requires the inclusion of fractions of second, if known. We adopt these standards and add the additional requirement that UTC time be used in all R2R navigation standard products.

An example date and time specified in this format is:

```
2009-08-27T13:30:00.000Z
```

The year is specified with four digits. The month, day, hour, minute, and integer number of seconds are specified with two digits. The number of digits to the right of the decimal place depends on the precision reported in fractions of a second. The day refers to day of month. The 24-hour clock is used to specify the hour. The hyphen ("-") is used between year and month, and between month and day. The capital letter "T" is used between date and time. The colon (":") is used between hour and minute, and between minute and second. The trailing capital letter "Z" specifies UTC time. No whitespace is allowed in this date and time format.

Ship's Position:

The ship's position is specified in units of decimal degrees, longitude followed by latitude. The bounds for longitude and latitude are as follows: -180 < lon <= 180 and -90 <= lat <= 90. We reproduce the GPS receiver precision. For example, if the longitude is recorded in the ship's data distribution to the nearest 0.0001 arc-minute, the longitude in the standard product will be reported to the nearest 0.000001 degrees (= 0.0001 arc-minute * 1/60 degree-per-arc-minute). The datum in common use by marine GPS receivers is WGS84.

Column Delimiters:

The tab ("\t") character is used to delimit columns, separating date/time, longitude, and latitude. Other whitespace characters are not to be used to delimit columns.

Flagging of bad positions in NavBestRes format:

Here, a bad position is defined as a position that results in a physically unreasonable horizontal speed or horizontal acceleration (for a ship, approx. greater than 1 m/s^2), a record with a poor GPS quality indicator

(an invalid fix or an estimate based on dead reckoning), or a record containing a duplicate or earlier date/time. A physically unreasonable speed is any speed greater than the vessel's maximum speed (as specified in the vessel profile) plus 2 m/s. The addition of 2 m/s allows for an instantaneous speed faster than the vessel's maximum speed, as when the GPS mast pitches forward in the direction of the track heading. It must also be remembered that the GPS horizontal position uncertainty for marine antennas is typically no better than 1 meter. A record containing a bad position will be flagged with a leading pound "#" sign.

(Bad positions will not be included in the Nav1Min and NavControl standard products and so flagging is unnecessary.)

File naming convention:

The file naming convention is to use cruise ID, underscore ("_"), lowercase "bestres", "1min", or "control", followed by the filename extension ".r2rnav" (all lowercase). An example for a cruise on the R/V Roger Revelle with a cruise ID of RR0902 is:

NavBestRes product: `RR0902_bestres.r2rnav`
Nav1Min product: `RR0902_1min.r2rnav`
NavControl product: `RR0902_control.r2rnav`

Examples:

The following are a few example records for each standard navigation product.

NavBestRes:

2010-01-11T23:56:01Z	176.182813	-37.648890	2	4	1	38
2010-01-11T23:56:02Z	176.182815	-37.648890	2	4	1	38
2010-01-11T23:56:03Z	176.182815	-37.648890	2	4	1	38
2010-01-11T23:56:04Z	176.182815	-37.648890	2	4	1	38
2010-01-11T23:56:05Z	176.182818	-37.648888	2	4	1	38

Nav1Min:

2010-01-11T23:56:01Z	176.182813	-37.648890
2010-01-11T23:57:00Z	176.182823	-37.648862
2010-01-11T23:58:00Z	176.182822	-37.648872
2010-01-11T23:59:00Z	176.182815	-37.648868
2010-01-12T00:00:00Z	176.182810	-37.648878

NavControl:

2010-01-11T23:56:01Z	176.182813	-37.64889
2010-01-13T06:01:00Z	176.481467	-37.521218
2010-01-13T06:24:00Z	176.579002	-37.510222
2010-01-13T07:38:00Z	176.887332	-37.454598
2010-01-13T08:00:00Z	176.976387	-37.440135

NMEA-0183 definition of GPS quality indicator:

The National Marine Electronics Association has defined the following values for the GPS quality indicator:

0 = fix not available or invalid

1 = GPS Standard Positioning Service (SPS) mode, fix valid
2 = differential GPS, SPS mode, fix valid
3 = GPS Precise Positioning Service (PPS) mode, fix valid
4 = Real Time Kinematic (RTK). Satellite system used in RTK mode with fixed integers
5 = Float RTK. Satellite system used in RTK mode with floating integers
6 = Estimated (dead reckoning) mode
7 = Manual input mode
8 = Simulator mode